

REMARKS/ARGUMENTS

Claims 1-21 are pending in the present application. Claims 1-14 and 17-21 have been amended. Reconsideration of the present application is respectfully requested in light of the foregoing amendments and following remarks.

I. Brief Overview of Present Invention

The present invention provides a method and a system for the balancing of a multiple rotor rotating machinery, and in particular a system and a method for balancing a three-shaft scroll pump where the shafts are not aligned end-to-end with one another, and where the axis of rotation of the three-shafts is not aligned along a common axis of rotation; that is the multi-rotor rotating machinery's shafts are not coaxial. In addition, the method and system are used for the balancing of a three-shaft scroll pump with non-coaxial shafts, that operates at a resonance condition at its normal operation speed. Each shaft of the motor has two counterweight attached at a location near the ends of each of the shafts; and which counterweights are used to balance the shafts and hence the three-shaft motor. Each one of the counterweight location is a correction plane and the combination of the multiple shafts, multiple correction planes and the resonance condition at the normal (1X) operating speed of the pump are such unique conditions that to the inventor's knowledge, no pump with these conditions has been successfully balanced. Using various transducers, vibration data is collected from measurement locations **where the number and positions of the measurement locations or planes are less than and different from the number and locations of the correction planes.** In particular, in one embodiment, while there are six correction planes (i.e., two counterweight locations near the ends of each of the shafts), the method and system of the presently claimed invention balance the pump using a lesser number of measurement planes (four in this case) by mounting velocity transducers two each on the machine's inner frame and outer casing.

II. Drawings

The Examiner has objected to drawings under 37 CFR 1.83(a). The Examiner has requested that a drawing showing the three shafts, the probe, the transducers, the inner frame, the outer frame, etc. be provided. Accordingly, Applicant is submitting herewith Figs. 4A-B depicting the locations of the shafts, the counterweights, the inner frame, and the outer frame of the pump, as well as the proximity sensor, the velocity transducers and the data acquisition system which are operatively connected with the pump and its components. Applicant respectfully submits that no new matter is being introduced by Figs. 4A-B, as the elements depicted have been set forth in the specification as originally filed, in paragraphs [25], [26] and [29] as well as the remainder of the specification.

Furthermore, a new paragraph [28.1] has been added to provide a short description for Fig. 4, which has been required by the Examiner.

III. Specification

Abstract

The Examiner has objected to the abstract of the disclosure because the legal phraseology of patent claims is used, and has required a correction. Applicant respectfully presents a revised abstract as is set forth above, removing the legal phraseology of patent claims. Applicant respectfully submits that the corrected abstract overcomes the Examiner's objection.

Claims

The Examiner has objected to claims 17 and 19 because of certain informalities, and has required appropriate correction. Applicant has amended claims 17 and 19 as set forth above to correct the informalities. Applicant respectfully submits the amended claims overcome the Examiner's objections.

IV. Claim Rejections - 35 USC § 112

35 U.S.C. First Paragraph Rejections

The Examiner has rejected claims 1-21 under 35 U.S.C. 112, first paragraph as allegedly containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. In particular the Examiner alleges that Applicant fails teach how one gets from data acquisition to measurement results, and also alleges that the Applicant fails to teach how to modify the RIC method to achieve a measurement result in the Applicant's procedure. Applicant respectfully disagrees. Applicant teaches how the general RIC method is modified, how the data is obtained and what types of results are obtained both before and after the balancing using the modified method. Applicant has disclosed these particular teachings beginning on line 19 of paragraph [27] and through paragraph [32]. These sections of the specification provide a detailed description in such a way that a person skilled in the art of maintaining or servicing a three shaft scroll pump, would be enabled to obtain vibration data, recognize resonance conditions for the machine, experimentally develop influence coefficients for the machine as it operates at resonance at its normal operating speed, and balance such a machine using the experimentally developed rotor influence coefficients, without undue experimentation.

While it is true that the Federal Circuit has held that "the specification must teach those skilled in the art how to make and use the full scope of the claimed invention without 'undue experimentation.'" *In re Wright*, 999 F.2d 1557, 1561, 27 USPQ2d 1510, 1513 (Fed. Cir. 1993), it has also held that not everything necessary to practice the invention need be disclosed. In fact, what is well-known is best omitted. *In re Buchner*, 929 F.2d 660, 661, 18 USPQ2d 1331, 1332 (Fed. Cir. 1991). All that is necessary is that one skilled in the art be able to practice the claimed invention, given the level of knowledge and skill in the art. Further the scope of enablement need only bear a "reasonable correlation" to the scope of the claims. See, *e.g.*, *In re Fisher*, 427 F.2d 833, 839, 166 USPQ 18, 24 (CCPA 1970). Applicant respectfully submits that the disclosure is detailed enough to enable a person skilled in the art of maintaining or servicing a three shaft scroll pump to practice the claimed invention without undue experimentation. Applicant is fully prepared to submit declarations from such skilled persons that the disclosure

filed enables one skilled in the art of maintaining or servicing a three shaft scroll pump to practice the claimed invention without undue experimentation.

Further, the Examiner has recognized one of the unique aspects of the presently claimed invention to be the vibration measurements at resonance. Applicant agrees that this feature is one of the novel features of the presently claimed invention as is recited in dependent claims 7 and 17. However, in addition to these novel features, the presently claimed invention includes balancing a rotating machinery that operates at or near resonance during its normal operating speed, and which has three separate shafts whose axes of rotations are not aligned along a common axis of rotation and counterweights connected near the ends of each of the shafts. The method includes obtaining speed and vibration data, by mounting velocity transducers on the machine's inner frame and outer casing. A data acquisition system is used to collect and analyze the speed and vibration data for steady state and transient operations. The method further includes adjusting the counterweights using a predetermined rotor influence coefficient determined experimentally using the same setup of transducers, to reduce vibrations below an acceptable level. The method and system collect data from measurement locations or planes where the number and positions of the measurement locations are less than and different from the number and locations of the correction planes. In order to further the prosecution of the application, Applicant has amended independent claims 1 and 13 without acquiescence and prejudice as set forth above to better articulate the present invention.

Further, the Examiner alleges that Applicant has failed to teach how each of the shafts is balanced by applying counterweight corrections in two correction planes, in particular the Examiner is referring to the language of paragraph [34] where the specification discloses that "although each shaft/arbor has its own imbalance with two planes for correction the resultant unbalance can be corrected as if there was only one shaft." Applicant respectfully disagrees and respectfully submits that the balancing of each shaft using shaft-end counterweight adjustments based on a previously determined rotor influence coefficient is taught in the specification beginning on page 11, line 27 and continuing to page 12, line 18. Furthermore, Applicant submits that since one proximity probe is coupled with the machine to measure one rotational

velocity, and the data is used to balance three shafts, it then follows that the claimed invention enables the balancing of three different shafts, each having its own shaft-end counterweight, while only measuring one rotational speed. In addition, Applicant respectfully submits that these teachings are detailed enough to enable a person skilled in the art of maintaining or servicing a three shaft scroll pump to practice the claimed invention without undue experimentation. As set forth above, Applicant is prepared to submit declarations from such skilled persons that the disclosure filed enables one skilled in the art of maintaining or servicing a three shaft scroll pump to practice the claimed invention without undue experimentation.

Further, the Examiner has taken issue with the language of paragraph [30] regarding the proper selection and placement of appropriate transducers. The Examiner alleges that it would involve undue experimentation to locate proper placement of various velocity sensors to achieve the desired measurement results. Applicant respectfully disagrees. Applicant's specification discloses that various sensor types may be used to collect vibration data, for example see page 5, lines 1-14, where Applicant has not only taught that either displacement, velocity or acceleration transducers may be used, Applicant has also taught that the claimed invention uses velocity transducers for vibration measurements and a displacement transducer (e.g., proximity) to measure the speed. Furthermore, the positions where such transducers are placed are disclosed in the specification beginning in paragraph [29] on page 10. Accordingly, Applicant respectfully submits that these teachings are detailed enough to enable a person skilled in the art of maintaining or servicing a three shaft scroll pump to practice the claimed invention without undue experimentation. As set forth above, Applicant is prepared to submit declarations from such skilled persons that the disclosure filed enables one skilled in the art of maintaining or servicing a three shaft scroll pump to practice the claimed invention without undue experimentation.

Further, the Examiner alleges that the Applicant's use of the term "planes" is inconsistent with the background art. While it is generally recognized that applicants are their own lexicographers, as long as terms are not used in ways that are contrary to accepted meanings in the art, as used in the Applicant's specification and as is generally recognized by those skilled

in the art of balancing rotating machinery, a plane is defined as either a location where measurements of rotor imbalance are taken, or where correction weights are applied to a shaft to reduce its rotational vibrations. For example, see page 9, line 15-16 of the specification, where it provides that all three shafts have two counter weights, which are used as the balance planes. Applicant respectfully submits that the above section 112 first paragraph rejections are overcome in view of the above claims amendments, drawings corrections and remarks.

35 U.S.C. Second Paragraph Rejections

The Examiner has rejected claims 13-21 under 35 U.S.C. 112, second paragraph as allegedly being indefinite. Applicant respectfully submits that claims 13-21 are directed to a system for balancing a pump, and as such includes a proximity sensor for providing phase and rotational velocity readings and velocity transducers for providing vibration signatures, as well as data acquisition system for collecting and analyzing the data, along with weights to be applied to the machine's rotors to reduce vibration levels. To better articulate and thus provide an adequate level of protection for the presently claimed invention, Applicant has amended claims 13-14, and 17-21 as set forth above. Applicant respectfully submits that the amended claims overcome the Examiner's 35 U.S.C. 112, second paragraph rejections.

V. Claim Rejections - 35 USC § 103

Claims 1-21 have been rejected by the Examiner under 35 U.S.C. 103(a) as allegedly being obvious over Applicant's own admission in view of USP 4,098,127 ("Shiga") and USP 4,485,678 ("Fanuelle"). Applicant agrees with the Examiner's characterization that some balancing is known. However Applicant also notes that the balancing as embodied by the presently claimed invention is novel and nonobvious for several reasons as set forth above. As set forth above, the presently claimed invention includes several novel features, which enable a method and system for balancing a rotating machinery that (i) operates at or near resonance during its normal operating speed, (ii) which has multiple separate shafts whose axes of rotations are not aligned along a common axis of rotation and counterweights connected near the ends of

each of the shafts; and (iii) collects vibration data from measurement locations where the number and positions of the measurement locations are less than and different from the number and locations of the correction planes.

To further the prosecution of the present application, Applicant has amended independent claims 1 and 13 as set forth above to reflect the novel features. Applicant respectfully submits that a hypothetical combination of Shiga and Fanuelle does not render the presently claimed invention obvious, because all of the elements of independent claims 1 or 13 are not taught or suggested by the combination of Shiga and Fanuelle. In particular, neither Shiga nor Fanuelle, nor a combination of Shiga and Fanuelle teach the balancing of a multi-rotor non-coaxial pump using less measurement than correction planes (for vibration data). Shiga teaches many possible computational planes that are more than the actual number of correction planes on a single axis of rotation (or coaxial) pump. In stark contrast, the presently claimed invention balances a multi-rotor pump having non-coaxial shafts that have more correction planes (two per shaft) by taking vibration data from fewer measurement planes, where the vibration transducers are placed on both an internal frame and an external casing of the pump. Shiga teaches a multi-span one-axis of rotation balancing where there are more measurement than correction planes. Fanuelle also teaches a single rotor single axis of rotation balancing. Also a review of Fig. 1 of Fanuelle shows that three sets of velocity measurement planes (i.e., more) are used for a single shaft balancing. Like Shiga, Fanuelle is deficient in teaching a method and system for balancing a multi-rotor non-coaxial pump that includes using a lesser number of measurement planes to balance the machine having more correction planes. Applicant respectfully submits that for reasons set forth above, amended independent claims 1 and 13, are nonobvious over Shiga and Fanuelle. In addition, considering that the dependent claims that depend from claims 1 or 13 include all of the limitations of their base claim, these claims are patentable at least to the same extent that their base claims are patentable.

Applicant has also reviewed the art not relied upon by the Examiner and notes that these references are all directed to single or coaxial shaft machines where there is one main

Appl. No. 10/032,384
Amdt. dated November 20, 2003
Reply to Office Action of May 21, 2003

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axis of rotation (as opposed to multiple) and where commonly there are more measurement planes than correction planes. As such Applicant respectfully submits that the deficiencies of the Shiga and Fanuelle references cannot be overcome by the Piety, Curtis, Ehrich, Matsushita, Bankert and Heideri references.

CONCLUSION

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 925-472-5000.

Respectfully submitted,



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